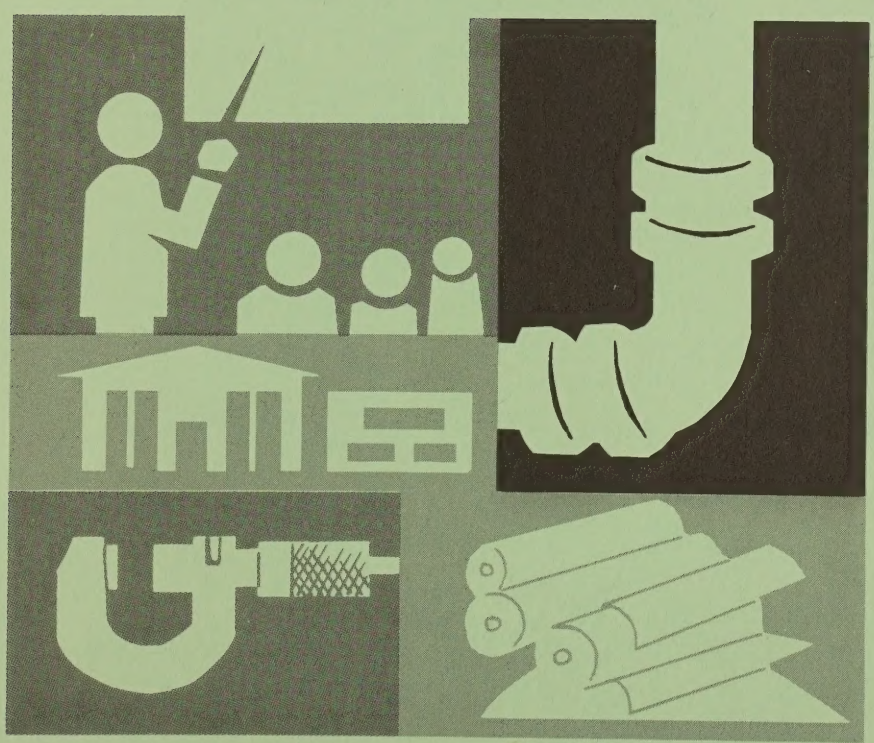
MANPOWER RESEARCH MONOGRAPH NO. 20

Toward the Ideal Journeyman

Volume 2. THE TRAINING SYSTEM IN THE PIPE TRADES



U.S. DEPARTMENT OF LABOR Manpower Administration

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Volume 2. THE TRAINING SYSTEM IN THE PIPE TRADES

1971

U.S. DEPARTMENT OF LABOR J. D. Hodgson, Secretary Manpower Administration

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PREFACE

This is the second volume of a monograph dealing with the American apprenticeship system being published by the Manpower Administration of the Department of Labor. It is based on a study completed in 1969. The study made an extensive examination of the strengths and weaknesses of American apprenticeship training in order to identify the elements that go to make up an optimum training program—one of maximum effectiveness in meeting the Nation's needs for craftsmen.

The portion of the study summarized here—apprenticeship training in the plumber-pipefitter trades in the construction industry—gives a picture of the training received by apprentices and journeymen. It proposes methods for overcoming problems of training that are both peculiar to the craft and common to the construction trades. Persons associated with other trades should benefit from the pipe trades' experience of more than 80 years in the operation of a national apprenticeship system.

The first volume dealt with the "optimum" model for apprenticeable training. In this volume, the emphasis shifts to the particular problems and the special needs of the craftsmen in the pipe trades, which employ about 220,000 men. Selected machine and printing trades receive similar coverage in volumes of the monograph that follow.

The basic research was done by a team headed by Alfred S. Drew, associate professor of The School of Technology at Purdue University, under a contract with the Office of Research and Development of the Manpower Administration. The Bureau of Apprenticeship and Training (BAT), as well as advisers from labor and industry, provided information for the study and gave invaluable guidance to the researchers during the conduct of the study and the preparation of the report.

CONTENTS

INTRODUCTION

This study is based upon surveys of apprentices and journeymen affiliated with the United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada (UA), AFL-CIO. However, suggestions for proper conduct of an apprentice training system came from every source connected with the plumbing-pipefitting trades. Manufacturers of plumbing material were questioned regarding innovation. Joint union-management training standards were studied and used to appraise success in meeting established goals. Joint apprenticeship committees administering successful programs were quizzed, as were instructors, coordinators, and employers. Often it was found that the industry already possessed the solution to a problem or weakness in a program, but it needed time or additional resources to put the solution into effect.

Throughout the study, the researchers were assisted by an advisory committee composed of union and management representatives who deal on a daily basis with the training needs of the pipe trades.

The researchers focused first on what makes a good journeyman. All categories of respondents gave top weight to four attributes: overall skill, high quality work, initiative, and ingenuity. Accorded significantly less weight were three other characteristics: leadership, special skills, and teaching ability.

Based on responses ranking these characteristics, the investigators concluded that a training program should turn out "generalists"—journeymen with a broad array of skills and knowledge—rather than "specialists." Large employers gave greater weight to leadership ability than did small employers; however, both large and small employers rated this characteristic higher than did instructors, journeymen, and apprentices.

Initiative was given very high rankings by employers, business agents, journeymen, and instructors of the UA, but it was accorded less weight by government officials, apprentices, and educators.

The next phase of the research was to find out what kind of training workers actually had and what kind is needed to produce the ideal journeyman. The details, reported in the following pages, point to a few major conclusions:

1. That traditional apprenticeship by itself is not enough; continuation training for journeymen is essential.

2. That although there are some means of keeping the training programs abreast of current developments, a systematic means of keeping the industry informed of new technology is badly needed.

3. That apprenticeship, while one of the oldest systems of training, is capable of adapting to new demands; recent apprentices are more likely to be older, married, and better educated than were those of a generation ago. Currently, less well educated, disadvantaged youth are beginning to enter and programs are being set up to enable them to compete for apprenticeship openings with youth who come from more traditional backgrounds.

A National Framework

The pipe crafts are divided into three trades—plumbing, steamfitting-pipefitting, and sprinklerfitting—and the national joint apprenticeship committees in the field reflect this. The National Joint Plumbing Apprenticeship Committee is comprised primarily of representatives of the UA and the National Association of Plumbing, Heating, and Cooling Contractors. The National Joint Steamfitter-Pipefitter Apprenticeship Committee is made up of representatives from the UA and the Mechanical Contractors Association of America. The sprinklerfitters' joint body is known as the Local 699 Joint Apprenticeship Committee; it is made up of representatives of UA Local 699 and the National Automatic Sprinkler and Fire Control Association.

Organization of the national plumbing training program is seen in figure 1, which shows the advisory capacity of the national JAC through the State level down to the local training program. At the local level, administrative control by union and employers extends through the local JAC to provide the apprentice with needed job and classroom training.

The national effort in training pipetradesmen is nowhere more evident than in the International Training Fund (ITF) set up by the UA and the National Constructors Association (NCA). This organization collects contributions, based on man-hours worked, from the plumber and pipefitter contractors who are members of the NCA.[1] The ITF makes funds available for capital equipment to be used by locally established programs, but it retains title to the equipment, tools, and supplies. It also supplements instructors' salaries and provides money for instruction materials. Since it began in 1956, the program has increased the number of journeyman training programs and has provided shop facilities for related instruction to many apprentices. The ITF passes upon requests for grants drawn up by local programs on the basis of needs. Such a program is particularly appropriate for an industry such as construction, where a worker does not work exclusively for one employer for a long period of time, making it difficult to distribute training costs equitably.

Apprentice Characteristics

Among the 480 apprentices at every stage of training who were scrutinized in the study, the most common age was 22; however, they ranged in age from 18 to 55. When they began their apprenticeship, nearly 38 percent were married, but at the time of the survey about twice that percentage were married. Among the married, three-fourths had children.

Seventy-five percent of the apprentices were high school graduates. An additional 20 percent had taken some form of study beyond high school. Two out of 5 apprentices envisioned training beyond that required for completion of their apprenticeship. A majority of these planned on college if they could get some financial assistance and could gain admission. The majority of those who planned to continue wanted to coordinate their trade training with college study.

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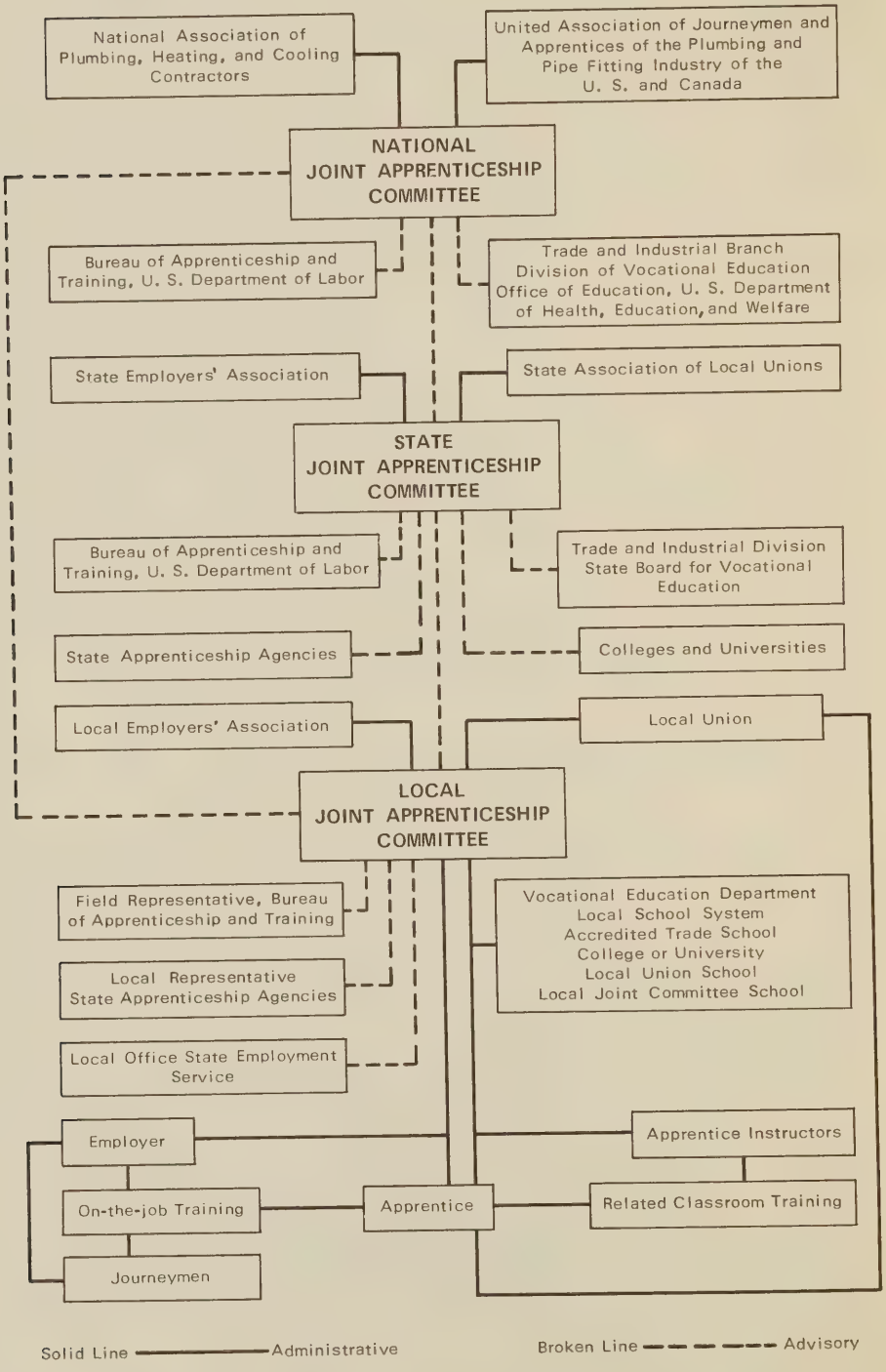
[1] The present contribution is 3.5 cents per man-hours worked.

Figure 1

APPRENTICESHIP SYSTEM OF THE PLUMBING INDUSTRY



The wage rate for the apprentices in the study varied from $1 to $5.25 an hour; the most common wage rate was $2 an hour. Generally, sprinklerfitters started at nearly two-thirds of the journeyman rate, while plumbers and pipefitters started at less than half. Advanced standing was granted to some apprentices—20 percent of pipefitter trainees, 9 percent of plumber apprentices, and 6 percent of the beginning sprinklerfitters. One year was the usual duration of the allowance, but credit for prior experience ranged from 3 months to 2½ years.

Of journeymen now working in the field, two-thirds credit registered apprenticeship programs as their main learning vehicle. In combination or by one method, journeymen reported receiving their training in the following ways: one in 10 finished a nonregistered apprenticeship program; 1 in 3 participated in special on-the-job training; about 1 in 4 attended a trade school, received some instruction from a union training center, or indicated that they just "picked up" the trade. Other sources of learning included military training, high school courses, company training centers, college, and partial completion of apprenticeship. When asked what method they valued most, journeymen gave highest marks to registered apprenticeship, OJT, and nonregistered apprenticeship. The quality of instruction was the aspect of apprenticeship they most appreciated.

ON-THE-JOB TRAINING

On-the-job training in the pipe trades, as elsewhere, is intended to familiarize apprentices with actual work processes, to instill pride in craftsmanship, and to foster initiative and ingenuity in actual job situations. A successful system of on-the-job training must provide work experience with up-to-date materials and processes, offer a breadth of experience, and be geared not only to production schedules but also to the needs of the trainee. Ideally, progressively greater challenges to the apprentice will be offered at each level of work experience. Journeymen are the prime source of on-the-job trade instructors. A good OJT experience presupposes a good relationship with these and other instructors.

The greatest concern of apprentices with on-the-job training centered on production versus instruction. One apprentice in 4 was concerned that journeymen and instructors do not have enough time to help. About the same proportion was concerned over the lack of variety in work assignments; a somewhat smaller proportion felt the assignments were too often without challenge. Those who said instructors or journeymen were not willing to help numbered 1 in 8.

When the apprentices were asked to select from a list several of the greatest benefits of their OJT experience, they responded as follows: 58 percent liked the opportunity to earn while learning; 50

percent liked working with journeymen or instructors; 48 percent cited rotation of work stations as affording a rounded experience; 43 percent thought the willingness of journeymen and instructors to help was a good feature; 40 percent noted challenging work assignments; and 38 percent liked the concept of learning work routines while working on daily production. About half of the apprentices saw "no serious problems" in OJT.

Apprentices were rarely asked by their employers to evaluate their OJT experience. Only 1 trainee in 3 indicated that he was given the opportunity to appraise his job experience on a regular basis.

Half of all apprentices said they were rotated from one job to another deliberately at least once a quarter. Forty percent said they were hardly ever or never deliberately rotated. Sprinklerfitter apprentices were most frequently rotated.

Most of the apprentices felt they had enough trade knowledge to complete the usual work assignments without assistance. One trainee in 13 said that he needed help at least once a week and the same proportion said that they needed it at least once a month. When help was needed it was generally available; four-fifths of those surveyed worked alongside journeymen every day. Some apprentices had a particular person to go to for help; for most of these, this was possible on a daily basis. Those who worked without much journeyman contact were probably apprentices who had acquired enough skill to assume some of the duties of the journeyman and work under the supervision of the contractor. When these apprentices reached impasses in their work, they either watched others, referred to a manual, talked to a foreman, or consulted a journeyman with whom they had worked before. A small number of apprentices—about 1 in 5—were given instruction on the job by factory representatives. But such opportunity arose once every 3 months at the most.

Trade reference materials in addition to those belonging to the individual were available to 2 out of 5 apprentices. Some of those who did not have access to reference manuals and handbooks indicated that they were expected to refer such questions to journeymen; however, most did not know why they were without such materials. Those who did have access to the materials said that the subject matter was clearly written and that they understood it without much difficulty.

About 70 percent of the apprentices reported that records were being kept on their OJT. Five percent believed that records were not being kept. Some apprentices said they did not know.

When asked to compare the schedule of work processes against their actual OJT experiences, 15 percent of respondents felt that they matched very closely, 17 percent that they matched fairly well, 12 percent that they differed fairly substantially, and 18 percent that they differed greatly. Over one-third of those surveyed were not sure or did not respond.

Journeymen selected the weakest areas in OJT to be scheduling actual training times and checking the apprentices' progress.

Work processes which some would have added to their OJT experiences include more service work, welding, and additional work from prints for pipefitters. Plumbers also noted welding and brazing as well as working from layouts and plans.

Training officials in the pipe trades stressed that each apprentice must be given work experience in all phases of the construction industry. Because of the compartmentalized nature of the construction industry, it is unlikely that one employer will be able to furnish the rounded experience which is vital to the development of a complete journeyman. A multiemployer rotation training effort becomes necessary. Training program administrators must plan and keep records; they must have the authority and responsibility to see that each apprentice gets the job training that he needs.

RELATED INSTRUCTION

Through classroom and shop training other than on-the-job training, an apprentice is expected to learn the trade theory that underlies the job skills he is expected to acquire. Such instruction could conceivably include anything which would make a plumber or pipefitter a more valuable employee for his employer.

Of high priority, then, is the coordination of the relevant trade subjects being taught in related instruction with the processes being learned on the job. Apprentices reported that this was the weakest area of their related instruction.

Apprentice Experience

Advanced standing as credit for prior experience was granted to some apprentices; 1 year was the common allowance, but it ranged from 3 months to 2½ years. Since apprenticeship is computed on the number of hours worked, some apprentices may, because of overtime, expect to complete their indentures in less than the normal calendar duration based on a standard workweek. Classroom hours for pipefitters ran from 1,000 to 1,080 hours in some programs to 720 in others. For plumbers the most common lengths were 720, 800, or 1,000 hours. Sprinklerfitters, since they rarely have enough trainees at one location for regular classes, take their related instruction through correspondence courses set up by Pennsylvania State University. They must complete 174 lessons requiring anywhere from 3 to 5 hours of study each.

Sprinklerfitter apprentices were relatively more dissatisfied with their programs of related instruction than were the other two groups. Fifteen percent held that their course of related instruction—conducted as it was through correspondence—did not have any good points. They obviously missed the opportunity for teacher-student dialogue. Regarding curriculum, they also voiced a degree of dissatisfaction that was not approached by trainees in other trades. Similarly, they were likely to be unhappier over lack of qualified instructors and the failure to teach manipulative skills.

Plumber and pipetrades apprentices experienced problems in related training, such as lack of good textbooks and visual aids, insufficient time spent on materials and equipment new to the trade, and related training sites too far from their lodging.

Nearly one-half of the pipefitters thought that their most recent course was "excellent." One-fourth of the plumbers and 14 percent of the sprinklerfitters so characterized theirs.[2]

Plumbers and pipefitters noted that the classes usually held between 11 and 20 students—all apprentices. Course goals were set out and followed; students knew what was expected for a passing grade. The content of the next period of class instruction was known in advance. Tests were the short-answer, objective type and were constructed by the teacher.

Instruction was generally provided by the union—either alone or in cooperation with management and/or the public schools—or by the schools alone. Public school facilities were used by more than half the students, but substantial numbers of the apprentices had their related instruction in union facilities or in a training center run by a JAC. A lesser number used employers' or private school facilities. As noted, however, sprinklerfitters studied with correspondence courses.

Plumbers and pipefitters tended to take classes during the regular school year, attending from 3 to 6 evening hours a week. The sprinklerfitters' correspondence courses were conducted yearround outside regular working hours. Pay for class time was received by one-third of the plumbers and pipefitters and by one-tenth of the

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[2] In 1967 a new series of texts was introduced by Joint Apprentice Text, Inc., which the chairman of the NAPHCC Apprenticeship Committee reports has received excellent ratings by more than 80 percent of the JAC's. In 1968, the Joint Apprentice Text, Inc., was renamed Joint Plumbing Apprentice and Journeyman Training, Inc.

sprinklerfitters. Most apprentices reported no reimbursement. However, the sprinklerfitters' tuition, books, and materials were generally paid for.

Half of the pipefitter and plumber apprentices were in programs that had more than one instructor and about 7 percent of these experienced team instruction in a given course. About 7 percent of the apprentices were in one-instructor programs, while the rest reported a variety of staffing arrangements. At least half of the apprentices were addressed by guest speakers on a fairly regular basis; however 1 apprentice in 5 was never exposed to a guest speaker. Visitors from JAC's or management groups were even less common during the first year of instruction—only one-fourth of the apprentices reported such visitors.

A variety of teaching techniques and methods was used in plumber and pipefitter related instruction; a substantial majority of apprentices indicated that the manner of instruction changed at least every class period. Apprentices reported such techniques as lectures, supervised study, and programed instruction. Instructional aid varied; a majority of apprentices used textbooks and worksheets every session and very few were exposed to radio, recordings, television, and correspondence study. These less frequently used aids were highly valued when used. Films, photos, and slides—as well as charts and graphs—were in general use. When they were used, a majority thought them "very helpful." The use of actual trade materials and equipment was reported by 8 out of 10 apprentices, who considered such instruction more beneficial than any other method. The equipment used was nearly always characterized as "up to date."

Apprentices' preferences for related instruction generally conformed to the manner in which they were taught. Correspondence was the method of instruction preferred by three-fifths of sprinklerfitters, while comparable proportions of pipefitters and plumbers favored group instruction. Some of the latter, however, indicated that they would like to try some form of individual study as long as they were not put totally on their own. Also, apprentices preferred to study with members of their own trade; they preferred classes to be taught by an instructor who specializes in that subject; and they preferred to study trade theory before or at about the same time as they needed to use it on the job.

Course Content

Curriculum is a major concern for those who plan related instruction: In view of the limited resources, where should the emphasis be? How much reliance should be placed on the experience of present and former apprentices? How much on present analyses of the trade? How much on projections?

Journeymen tended to think that the curriculum offered them when they were apprentices was too scant rather than too broad. The most useful subjects for pipefitters were listed in the following order: science, mathematics, technology courses in heating and refrigeration, print reading and drawing, and welding and other manipulative skills. The order of value differed somewhat for plumbers: print reading and drawing, plumbing codes, mathematics, manipulative skills including welding and lead work, and science and theory. Generally, these are the presently required courses. Pipefitters thought that instruction in electricity and electronics, specifically as they deal with automatic control devices, would be a useful addition. Plumbers suggested inclusion of layout-detailing in their outside instruction. Useful work processes noted by pipefitters were as follows: welding-brazing; layout; fabricating, bending, and fitting of pipe; safe and proper use of tools; and rigging. The order for plumbers was: layout, soldering, plan reading and takeoff, use of tools, and pipe cutting and threading.

Presently required subjects for apprentices and the percentage for whom they are required were listed as follows. Note the large percentages of sprinklerfitters who are required to take nontechnical courses (English, economics, etc.)

Subject	Percentage		
	Pipefitter	Plumber	Sprinklerfitter
Drawings/prints	90	90	96
Economics	3	5	59
English	1	5	10
Hydraulics	38	28	98
Industrial relations	17	18	60
Labor movement/history	12	20	11
Mathematics	90	83	97
Metallurgy	23	14	4
Psychology	0	4	14
Science	24	26	3
Technology of trade	93	66	81
Other	25	19	6

Certain trade operations which had been taught conventionally on the job were noted in the "other" category, particularly welding for pipefitters and plumbers, and lead-work, brazing, and servicing for sprinklerfitters.

The most significant changes coming in the pipe industry in the years ahead were seen by manufacturers to be in the areas of fluidics, plastics, and other synthetics; more compact products; and quick-connect pipe ends and bonded joints. The skills that manufacturers thought journeymen would need in the coming years were ranked as: (1) Installation, calibration, and adjustment of control instruments; (2) diagnosis of malfunctions in balanced systems that are highly automated and possibly computerized; (3) testing for leaks; (4) starting up installations; (5) using plastic pipe; (6) joining materials using new techniques, especially in welding; (7) cleaning special installations (such as nuclear or cryogenic); and (8) using various types of precision instruments.

The pipe trades generally lacked curriculum planning guides. Nor were there comprehensive current occupational analyses on which to base such guides. The researchers developed a guide after conducting a trade analysis through use of a work diary, observations, and interviews.

The guide they developed from the trade analysis is to be used on the job or in the classroom for coordinating training and apportioning learning operations to the apprentice or the journeyman.

Researchers identified four major work divisions: preparing materials, joining materials, installing equipment and materials, and inspecting and testing. These blocks were broken down into "operational units," such as cutting-beveling, and then into specific activities, such as "using a tap to thread a brass flange."

An illustration is offered from block I in the appendix. (See p. 35.) Any method of preparing materials can be represented. Furthermore, this chart is able to indicate when, where, and how such a process is to be taught.

Using the guide, a JAC will have to decide what processes are suitable for training apprentices and what are suitable for training journeymen. Then the decision on whether to teach the process on the job or in the classroom must be made. How long does it take to learn the different activities? In what sequence should they be taught? Should they be taught in the order of the frequency they are needed in the trade, or in a logical progression such as materials

preparation before materials joining? Which should be taught first—operations critical to safety or those easiest to perform? Perhaps a combination of considerations will influence the order.

ADMINISTRATION

The body responsible for administering the training program has a big task. There are the problems of adequate facilities, equipment, and training materials. The problem of obtaining journeymen trained in teaching and up to date technically warrants special emphasis. Surveys of journeymen—usually by return postcard—were conducted regularly to learn their desires on course offerings. (See table 1 for this survey's report on journeymen suggestions for course offerings.)

TABLE 1. PIPE TRADES: CURRICULUM SUGGESTIONS FROM JOURNEYMEN WHO SERVED APPRENTICESHIPS

Pipefitters (n=133)[1]		Plumbers (n=101)[2]	
Most useful subject	Percent who selected subject	Most useful subject	Percent who selected subject
RELATED INSTRUCTION			
Science and theory	22	Print reading and drawing, including sketching, plan reading, isometrics, layout, drafting	29
Mathematics through trigonometry , ...	21		

Pipefitters (n=133)[1]		Plumbers (n=101)[2]	
Most useful subject	Percent who selected subject	Most useful subject	Percent who selected subject
Technology courses, such as heating, refrigeration, controls	20	Plumbing codes	15
Print reading and drawing, including blueprints, drafting, isometrics, layout	18	Mathematics	15
Manipulative skills, such as welding, rigging	17	Manipulative skills, such as welding, lead work	14
Other entries	2	Science and theory	13
		Technology courses, such as heating, controls, instrumentation	9
		Other entries	5
ON-THE-JOB TRAINING			
Welding-brazing	19	Layout	17
Layout	11	Soldering	11
Fabricating, bending, fitting pipe	10	Plan reading and take-off	9
Safe and proper use of tools and equipment	9	Safe and proper use of tools and equipment	8
Rigging	8	Pipe cutting and threading	7
Reading blueprints	7	Lead work	6
Wiring and checking controls	6	Welding	6
Planning and coordinating job	5	Application of codes	5
Other entries	25	Other entries	31

[1] Number of those queried equaled 133; for most useful subject, 115 respondents; for most useful OJT, 109.

[2] Number of those queried equaled 101; for most useful subject, 87 respondents; for most useful OJT, 72.

Certain problems were overcome by all of the outstanding programs. Problems must be recognized as being inherent in any training situation but as being not insurmountable. Formulation of a clear statement of objectives, general and specific, is no easy task, yet it must be one of the first hurdles passed or else the entire program founders. Reluctance of some employers to participate in interfirm rotation of apprentices is frequently encountered; this must be overcome to provide apprentices with sufficiently broad experiences for them to become the fully rounded "ideal journeyman." The need for scientific development and application of performance examinations and selection tests is challenged by those who do not wish to lose control over these aspects of training. Fairness and the ultimate quality of the journeyman demand such screening and testing procedures, however. The need for professional and specialized training for directors of programs, coordinators, joint committee members, and on-the-job instructors must be recognized. Busy men must take time from their schedules for this training. Recordkeeping, while not now a problem as far as related instruction goes, is essential to assure that apprentices are receiving the intended instruction and to assure proper credit for work completed. Sufficient and reliable testing of trade progress is a problem for the controlling body—not just for the instructor.

The pipe industry has developed a number of approaches toward solving problems in related instruction—such as the correspondence instruction developed for the relatively small sprinklerfitter trade. Some programs are experimenting in reducing duplication in training. In South Bend, Ind., for instance, the first 2 years of training for plumbing and pipefitting apprentices are combined. The International Training Fund, as noted, has contributed training funds to supplement trade instruction available through the public schools.

The 20-year-old Joint Apprentice Text, Inc., was recently expanded to include preparation of instructional materials not only for the plumbing apprentice and his instructor, but also for the journeyman and the foreman. The new title, Joint Plumbing Apprentice and Journeyman Training, Inc., reflects the change. Pipefitters' training materials are developed under the National Joint Steamfitter-Pipefitter Apprenticeship Committee for journeymen, apprentices, and instructors.

In the early 1960's the Joint Apprentice Committee for the Plumbing and Pipefitting Industry in New Mexico developed the

concept of mobile welding schools after years of operating permanently located training schools. A trailer-van was equipped with 10 oxyacetylene and 10 metalarc welding units and related equipment financed by the International Training Fund for a total cost of approximately $18,000. In two 11-week periods, 33 students were enrolled, 23 completed the program, and 19 were certified as welders. The cost per hour of instruction was $2.80 per student, not counting setup costs. The committee is considering going ahead with another unit, and other mobile classrooms have been employed in other areas.

Good training implies good instruction, and pipetradesmen regarded their instructors as helpful and cooperative. They considered them willing, in 9 out of 10 cases, to go back over explanations, demonstrations, and instructions. In their most recent course of study, very few apprentices noted any hostility to questions or comments. Most felt they were encouraged to speak up if they had something to add or if they were confused. Class presentations for most of the apprentices were both clear and interesting. But a number said that presentations lacked interest.

About 80 percent of apprentices reported that they were encouraged to be self-reliant but, as with OJT, the sprinklerfitters were most apt to say that they were "never" encouraged to solve problems on their own. Some 90 percent of pipe trades apprentices reported that pride in craftsmanship was stressed in their latest course.

Most instructors—9 out of 10 by the study's figures—are journeymen in the pipe trades. About half of the instructors, both in OJT and related instruction, are journeymen who both teach and work as tradesmen. Other sources of instructors are full-time nonjourneyman schoolteachers, plumbing inspectors, estimators, and job foremen and supervisors.

In OJT, 14 percent of pipefitters and plumbers were taught by a full-time journeyman instructor, as were 4 percent of sprinklefitters. In related instruction, 29 percent of apprentices reported having a journeyman instructor who was also working at the trade. Pipefitters are much more likely than plumbers to have a special "instructor-coach" or "coordinator" for related instruction. About 1 of 10 pipefitter apprentices reported that such an individual was their last instructor.

Most journeymen instructors had taught for about 10 years. Their experience ranged from 1 to 35 years. Three out of 4 had received no instruction in teaching.

Journeymen with the most frequent contact with apprentices were those who expressed the most interest in service as instructors. How much of this is a result of conscious assignment and how much a result of exposure to apprentices is not known.

From one-half to two-thirds of the journeymen have an interest in serving as instructors. About 1 in 5 attach no conditions, while the others specified that they would serve as instructors if they were trained or given adequate pay.

Those who are motivated to teach and who have the qualifications should be encouraged to do so. Training for instructors has been made easier in the pipe trades through the UA's Instructor Training Program. This program was begun in 1954, with the cooperation of Purdue University. By 1969 it had grown to 1,000 enrollees in 1 week, summer-term programs. Five-year instructor programs are held for pipefitters, for plumbers, and for sprinklerfitters. These are divided into courses in professional and technical subjects and applied knowledge. The title of "Certified Instructor of Journeymen and Apprentices in the Plumbing and Pipefitting Industry" is accorded graduates. There are also postgraduate courses, as well as seminars for training directors and coordinators, and workshops on new technologies for selected instructors.

UPGRADING AND KEEPING PACE

The researchers attempted to identify the mechanisms affecting the ability of the labor force to stay abreast of the changing needs of industry. Keeping subject matter and training methods current is essential to an optimum apprenticeship training system. For the journeyman, continuation training is necessary to combat skill obsolescence. For the manufacturer, it is vital that there be enough tradesmen with current skills to handle the innovations flowing from ever developing technology.

Being out of touch with new developments was a serious problem, many journeymen agreed; most said that it was at least a "moderate" problem. More than one-third of the journeymen reported having work assignments, at least monthly, which they did not feel competent to handle without some quick study. What avenue do journeymen use when they wish to broaden their skills?

In the order of frequency of use, the methods ranked as follows:

1. Trade journals
2. Talks with fellow tradesmen
3. Manufacturers' service bulletins
4. Talks with foremen and supervisors
5. Special union reports
6. Talks with union representatives
7. Talks with manufacturing representatives
8. Talks with trade instructors
9. Attendance at training schools
10. Attendance at public vocational school

The researchers suggest that greater emphasis may be put on trade journals' role in keeping journeymen aware of advancing technology because of their use by three-fourths of the tradesmen. The other major suggestion is provision of more schooling, since most of the tradesmen who did attend classes felt that this was the best method of learning.

Continuation Training

Half the pipe trades journeymen had not been asked about their needs for training during the preceding 2 years. Similarly, the chances were only about fifty-fifty that a journeyman had been participating in any supplemental instruction during the 2 preceding years. Interest in and commitment to further training appeared high, however, especially among the young married journeymen with dependents and among tradesmen who see skill obsolescence as a problem.

At present only 1 journeyman in 5 is required by the union, the employer, or the JAC to participate in additional training as a requirement of employment; however, this is a much higher proportion than that found in the other trades. More than 42 percent of journeymen reported that no record was being kept of the training they did receive; another 29 percent did not know of any recordkeeping. If done at all, generally it was done by the union. Some 19 percent of journeymen who participated in training reported that they received their regular hourly pay during this time, 5 percent reported being paid overtime for training; and 6 percent said they received a portion of their hourly rate for training. Others received financial help with tuition or books and materials, while 38 percent reported no assistance.

For the 45 percent who recently had participated in training, frequently reported classes were air conditioning, drawing and print reading, instrumentation and controls, electricity, building and cost planning, and welding. But some of the courses were very brief. (Only 3 men in 10 had participated in a training course lasting 10 hours or more.) Journeymen who had worked the longest were the least likely to engage in outside related training. Of journeymen being paid journeymen's wages for more than 10 years, 40 percent of the pipefitters and 51 percent of the plumbers had not taken a course of 10 hours duration for the past 10 years.

When asked if they wanted more training, 6 men in 10 replied "yes." One man in 10 said "no." The others were divided between those who were undecided and those who would take more training if it became necessary to keep their jobs. Pipefitters were more likely than plumbers to want additional training. A correlation also was found between age and training desire; if a journeyman is under 45 years old, he is a likelier prospect for extra training; this is also true if he is married and has one or more other dependents. Completion of high school and completion of apprenticeship were two more variables having a positive correlation with desire for more training, as was a journeyman's perception of skill obsolescence as a personal problem.

Journeymen were asked how much of their own time and money they were willing to spend on training. Over half would not pay more than $1 for each hour of instruction and some would not even pay that. One in 10 would pay up to $3 an hour. Thirty percent were willing to put out $100 a year for instruction and a similar percentage would pay more, but approximately 12 percent would make no annual investment. Two-fifths of the respondents said they were willing to attend class once a week and a slightly higher proportion said they would go two or three times. Willingness to travel a distance to get training was fairly high, although 7 percent indicated they would not walk across the street for classes.

Journeymen tended to prefer training with other journeymen, or perhaps advanced apprentices, in the same trade. They preferred instruction that combined both trade theory and manual skills. They wanted trade theory taught before or at about the same time as it would be needed on the job. Pipefitters tended to prefer different instructors for manual skills and trade theory. They preferred group training to home study. Training conducted at the jobsite was slightly favored over training away from the jobsite.

Some journeymen set conditions for taking additional training. For example, nearly half wanted the training to be jointly sponsored by labor and management. Two in 10 asked that the training be relevant to their work. One in 10 suggested that they would have to be assured credit toward certification in order to participate. Lesser numbers demanded that they be paid for the time spent in training and that training be sponsored exclusively by their labor union.

Manufacturers' Stake

Manufacturers, who were asked about the biggest bottleneck to the introduction of new materials, parts, and equipment did not feel that this was unions or pipetradesmen. Only 14 percent of the manufacturers queried indicated that labor unions gave them the most trouble with their products; only 9 percent indicated that individual journeymen were their greatest obstacles.

Some 40 percent considered architects and engineers who are responsible for the specification of equipment to be the biggest obstruction to the introduction of changes. Twenty-nine percent named the writers of building codes. Dealers, distributors, customers, and other manufacturers—taken together—were listed as obstacles by 8 percent of the manufacturers.

But when manufacturers were asked whether the course content of present apprentice programs would be adequate to meet trade needs 5 years from now, 60 percent thought not, whereas only 20 percent thought they would. Others were not sure. Those that felt the program content would need changing were equally divided as to whether it needed more OJT or more related instruction.

Suggestions made by manufacturers for keeping up to date included reading of trade literature, followup programs for journeymen, increasing public funds to provide modern equipment to training programs, and providing manufacturers with up-to-date listings of training programs offered by trade schools. Other proposals were to include in collective bargaining agreements incentives for updating skills, to conduct trade shows for journeymen and apprentices, to expand the present UA instructor training program to include journeymen on the job, to strive toward industrywide coordination of training, and to use mobile training units to bring demonstrations to jobsites.

Methods of keeping their own employees up to date included periodic reviews of programs in light of new technology, presentations of new products by the sales personnel to the apprentices' instructors, and periodic synopses of new technologies. Of 20 manufacturers who reported active apprenticeship programs in their plants, 12 were satisfied that their graduates were keeping pace with technology, four did not respond and four were dissatisfied.

Some 6 out of 10 firms provide training materials or instructors to apprenticeship programs. The materials range from catalogs,

technical bulletins, and manuals to lesson guides and course outlines for specific use in training. About 40 percent of the manufacturers provide visual aids or working mockups. Some provide tools, equipment, samples, and scrap parts. For the most part, instructors are provided at the manufacturers' expense; however, some companies charged token fees.

Installation help in the form of training was offered by 60 percent of producing companies, although some furnish it only if asked. Seventy percent of all producing companies include instruction manuals with their equipment; 40 percent send servicemen to aid in installations; 40 percent prepare information to "up date" journeymen; and 12 percent write maintenance contracts.

Marketing techniques almost always included the use of trade magazines and papers; some manufacturers even arranged releases for newspapers and some used direct mailings. When asked to describe the efforts which would be put into a product that could increase their sales by 30 percent and which would require new skills by installers and changes in local building codes, the manufacturers said that they would: (1) Publish instruction manuals; (2) call in sales and service personnel for special training; (3) have these personnel then conduct training programs for key distributor-sales people and major users; (4) offer training for all dealers' service personnel; (5) enlist help of potential users in seeking to change codes; and (6) appear before legislative bodies responsible for the building codes. Very few firms would institute a training program for journeymen as a primary step in helping to develop new skills necessary to install their products; generally, distributors were expected to fulfill this function. It was also noted that manufacturers generally do not design products if they are going to be in conflict with building codes.

A question on "lead time"—the time it would take a product to go from various stages of market readiness to general acceptance by journeymen with the skills needed to handle the product—yielded widely varying responses. Consequently, the researchers concluded that the time required for preparing workers would depend on what the product or process was, who the manufacturer was, and the point at which the new technology would be noted by a "responsible training agent."

Ten local training programs of top quality were visited in the course of the Purdue investigation. Interviews were held with the

JAC and its training director or coordinator in order to solicit suggestions on what elements compose an outstanding program. The facilities were examined and training records and instructional materials were reviewed.

Uniformly, the outstanding programs had joint labor and management apprenticeship committees. Appointments to these committees were staggered and the chairmanship alternated between management and labor. No pay for the services of representatives was accorded even though regularly scheduled meetings were held and recorded. The JAC must be cognizant of its responsibility for the program and its resultant authority over the program. Members should visit training sites and sessions periodically.

It was maintained that the parties to training must believe in the system of training and, beyond that, have formulated goals and objectives understood by and agreeable to all parties involved in the training. An employer should prefer to employ graduates of the program. He should feel that his investment in training is paying off.

A trust fund committee of labor and management should be established to provide a precise training budget. And, if feasible under the budget, a full-time training director should be appointed to be responsible to the JAC.

KEYS TO EFFECTIVE TRAINING

The research advisory committee together with the administrator and training coordinators of the International Training Fund outlined the essentials of a high quality program. Their views which follow, take account of some recent innovations made in the pipe trades such as ITF and instructor training.

"Joint Interest in Training.—Members of the local union and employers have a sincere interest in the training of apprentices.

"Joint Apprenticeship Committee.—The duties and responsibilities of a JAC are spelled out in national and local standards; it is the degree to which the standards are applied on a local level that determines the contribution a local JAC will make to the success of the program. The good program will have an active joint apprenticeship committee—one that meets regularly and lives up to the duties that are spelled out in the standards.

"Instructors—Related Theory and Related Shop Classes.—Instructors are key men in any apprenticeship program. Care must be exercised in the selection of these men. The good program will take advantage of the various state and national instructor training programs by having its instructors attend.

"Adequate Physical Facilities.—The good program will have an up-to-date facility in which to carry out related training classes. Schools with adequate space, light, heat, modern tools,

equipment, and training aids provide an incentive to learning not found in schools lacking these items.

"Variety of Work Experience (On-the-Job Training).—The good program will have developed a system whereby each apprentice is given work experience in all phases of the industry. Rotation of the apprentices by the JAC from shop to shop or job to job is one method of accomplishing this.

"Periodic Review.—Periodic reviews should be conducted to determine: (1) whether the curriculum is being kept up to date; (2) individual progress and school attendance records of each apprentice; (3) the condition of equipment and supplies; and (4) the overall performance of the instructors.

"Adequate Financing.—A good program provides for adequate financing, e.g., through the technique of cents-per-hour contributions by participating employers under a collective bargaining agreement. The apprentice committee will also be familiar with technical and financial assistance from the United Association Training Department for Apprentices and Journeymen, the International Training Fund, and public sources such as Smith-Hughes and George-Barden legislation."

This, the "best testimony" of the industry's training experts, is paralleled to a degree by the national standards adopted by the various pipe trades for registry with the Bureau of Apprenticeship and Training.[3]

National Apprenticeship Standards

As registered programs, the pipe trades apprentice training systems must have met these national guidelines: A starting age for

[3] In 1937 the National Apprenticeship Act (the Fitzgerald Act) was passed. The Bureau of Apprenticeship and Training, Manpower Administration, U.S. Department of Labor, administers the act. The Bureau is charged with an advisory capacity to encourage joint cooperation by management and labor to establish and maintain apprenticeship programs. In connection with its advisory capacity, BAT is empowered to register programs which are not covered by State certification and which meet the standards set down by the Federal Committee on Apprenticeship. BAT maintains records of standards set down by programs registering with it. National standards are on file at BAT for national apprentices' programs for both plumbers and pipefitters, as well as standards affecting apprentices of Local 669, the sprinklerfitters.

apprentices of not less than 16 years; full and fair opportunity to apply for apprenticeship; selection on basis of qualifications alone; schedule of work processes in which a trainee is instructed; a minimum of 144 hours a year in organized instruction in subjects related to his trade; a progressively increasing schedule of wages; supervision of OJT facilities; periodic evaluation of apprentices' progress; keeping of records; employee-employer cooperation; recognition for successful completion of apprenticeship; and nondiscrimination in all phases of apprenticeship employment and training.

Standards for programs on record with BAT generally cover 18 to 20 major subjects; the pipe trades are no exception. The subjects include composition and duties of the local JAC, ratio of apprentices to journeymen permitted on jobs, standards and procedures, the apprenticeship agreement, probationary periods, term of apprenticeship, wage rates, working hours, work experience, supervision on the job, related instruction, certificates of completion, and relevant definitions.

The plumber apprenticeship program standards include the suggestion that a JAC or similar committee act on all training matters, including administration of advanced or continuation training programs for journeymen. Both pipefitters and plumbers advocate transfer of apprentices from employer to employer when it is needed to provide the trainee with the breadth of experience his program calls for. Standards tended to be unclear in assigning authority and responsibility for training of apprentices on the job.

The pipe trades went beyond the standards of most other trades in advising about assistance available from contractors, the UA, BAT, State apprenticeship agencies, and the U.S. Office of Education. The pipe trades are approaching the concept of a complete training system as suggested in the first volume on the optimum program. Also, the pipe trades are relatively unique because in their standards, a major section is devoted to the suitability of particular employing firms for training apprentices.

Minimal treatment was given in the pipe trade standards (in contrast to those of other trades that were studied) to schedules of work processes, responsibilities and obligations of apprentices, credit for previous experience, joint training funds, and "coordinators of apprentices." Lack of inclusion of a particular subject as a

standard does not mean that the programs as they actually are run ignore the subject, however,

Study Conclusions

The apprentice agreement should be executed among the apprentice, the JAC, and the employer. It should include statements covering terms and conditions of employment, schedule of trade processes, and requirements for related instruction. Registration of the agreement with State or Federal agencies is important.

The best apprenticeship programs examined were attuned both to the general needs of the trade and the local needs of the industry. Apprentices should be made aware not only of what local practice is, but also of how a process or technique might be accomplished in another way in another area.

The apprentice must be rotated on the job through all work processes, spending an adequate amount of time in each area of the trade. To accomplish this, rotation through several different firms may be necessary. Records must be kept and reviews made at intervals by the JAC or the director. Records covering related instruction need the same attention.

On the job, apprentices should be placed under journeymen and supervisors who have an interest in apprentices and who are willing to help them.

Apprentices should participate in related instruction under a system of rules and regulations known and applied to all. A demerit system for absence, tardiness, insubordination, and defacement of property is appropriate. Some JAC's advocate making the apprentice bear the cost of makeup courses or even withholding promotion pay increases until school work is satisfactory. High standards need to be upheld on and off the job.

Periodically, apprentices should be examined to determine progress. Examinations may be of the written, oral, and/or performance type. They should be given toward the end of the probationary period, before advancement to the next wage grade, and before conferring journeyman status. Scholarship awards are appropriate, as are awards for perfect attendance or any other achievement which should be encouraged.

Instructors must know how to teach and be given time to prepare lessons. Inservice training should be provided for them. Dedication should be rewarded through good pay. Good pay should in turn provide sufficient numbers of dedicated instructors. There should be enough instructors to allow each to concentrate on a special trade area or related subject.

Continuation training for journeymen is provided in the overall training system of outstanding programs. Certificates are awarded upon completion of training courses.

Trade contests based on job skills and knowledge are employed in the programs the research team visited; nearly every program had its national or regional winners.

School facilities should have a full-time manager who provides the administration and coordination necessary for related instruction. When he is employed, lines of authority and responsibility are clear for such schools, and channels of communication to the JAC, instructors, and trainees are strong.

Besides sufficient classroom space, high-quality programs have facilities for developing and storing instructional materials, reproduction equipment, and offices for training personnel. Facilities, tools, and equipment are modern, operational, *and* used by trainees. Shop facilities are such that they can be used either for individual instruction or practice or for group instruction.

When public school facilities were used by local JAC's for related instruction in the better programs, this was done as an adjunct to use of industry controlled facilities. Courses at different levels of instruction or in additional subjects were offered by the industry schools, thus expanding the offerings of the public school.

Provisions for preservice or inservice instruction exist in the better programs for teachers and others who are involved in related instruction or journeyman continuation training. Nationally developed "instructor guides" and other instructor aids were made available. Chalkboards, flipcharts, transparencies, films, models, simulators, etc., were provided.

Trainee-instructor ratios were between 12 and 20 to 1 in the classroom, and between 10 and 12 to 1 in the shops and laboratories. These were "reasonable" proportions, according to the researchers.

Various methods of instruction were used in training sessions, e.g., illustrated lecture, discussion, demonstration, supervised study.

Every outstanding program utilized the International Training Fund and its regional coordinator. There was a high *esprit de corps;* one "especially enthusiastic" person from each outstanding program was engaged in applied research in the trade or in the development of special training materials.

Very often apprentices were themselves involved in developing simulators and other training aids, work stations, equipment, and other projects designed to improve the training environment.

The study team noted that the quality programs are generally large. A sufficient number of applicants was available to maintain television and computer assisted instruction. A program will have to make the best adaptation of that method that circumstances demand.

The research team concluded that while the elements that go to make up a good system of training are known, the weaknesses in the system stem from the failure to administer, coordinate, and control—that is, to put into practice—these well recognized elements. Based on the responses from apprentices, journeymen, employers, union officials, manufacturers, and others, it became apparent that certain distinct characteristics made "outstanding" trade training programs. To repeat, these programs can be defined as those producing the "ideal journeyman"—one possessed of overall skill who can handle any job in the trade however complicated; who has the initiative to move from one job to another with a minimum amount of supervision; who produces high-quality work; and who has the ingenuity to accomplish whatever task is assigned even though the tools, materials, or equipment available may not be the best for the job.

The study stresses that achieving an optimum training system requires much time and effort from those concerned, Yet, when key principals are applied in a systematic and unified way, they can unlock fully the potential talents of the American craftsman.

APPENDIX

CURRICULUM PLANNING GUIDE— OPERATIONS AND ACTIVITIES

TRADE_____
BLOCK I: Preparing Materials
OPERATIONAL UNITS: A. Cutting & Beveling B. Deburring C. Threading
D. Forming E. Cleaning F. Aligning G. Preheating

A. Cutting & Beveling (with):
1. hand hacksaw
2. power hacksaw
3. pipe cutter
4. abrasive wheel
5. burning torch
6. chisel
7. glass cutter
8. lathe
9. metal snips
10. rasp

B. Deburring (with):
1. tapered reamer
2. file
3. chisel
4. abrasive

C. Threading (with):
1. hand die
2. power die
3. portable power drive & die
4. tap
5. lathe

D. Forming (with):
1. hand bender
2. power bender
3. beading tool
4. flaring tool
5. flanging tool
6. dresser tool
7. drill

E. Cleaning (with):
1. abrasive
2. file
3. chemical
4. wire brush
5. chipper

F. Aligning (with):
1. straight edge
2. framing square
3. chalk line
4. plumb bob
5. level
6. line clamp

G. Preheating (with):
1. gas torch
2. furnace
3. resistance heating coil
4. induction heating coil

WHO? A	WHO? J	WHERE? REL.	WHERE? OJT	WHAT? Prepare:	by Cutt	HOW? Forming	ting
				a. lead			
				b. aluminum and aluminum alloys			
				c. copper and copper alloys			
				d. brass			
				e. clay			
				f. glass			
				g. stainless steel			
				h. plastics			
				i. cast iron			
				j. nickel and nickel alloy steels			
				k. carbon and low carbon steels			
				l. transite			

CURRICULUM PLANNING GUIDE—
OPERATIONS AND ACTIVITIES—Continued

TRADE:_____

BLOCK II: Joining Materials

OPERATIONAL UNITS: A. Coupling B. Caulking C. Soldering
D. Brazing E. Welding F. Bonding

A. Coupling (with):
1. flare connectors
2. compression connectors
3. threaded sleeves
4. compression sleeves and "O" rings
5. caulking sleeves
6. unions
7. flanges, bolts, and gaskets

B. Caulking (with):
1. lead
2. oakum
3. tar compounds
4. cement
5. patented inserts

C. Soldering (with):
1. wiping solder
2. soldering iron and solder
3. heating torch and solder

D. Brazing (with):
1. oxyacetylene torch and filler metal
2. oxyhydrogen torch and filler metal
3. other gases, torch, and filler metal

E. Welding (with):
1. oxyacetylene torch and filler metal
2. other gases, torch, and filler metal
3. (tungsten) inert-gas metal-arc welder and filler metal
4. (metal) inert-gas metal-arc welder and consumable electrode
5. electric-arc welder and filler metal
6. hot air torch and plastic filler

F. Bonding (with):
1. adhesives

WHO?		WHERE?		WHAT?	HOW?	
A	J	REL	OJT	a. Join Lead (to):	by Coupling	Bonding
				(1) lead		
				(2) aluminum and aluminum alloys		
				(3) copper and copper alloys		
				(4) brass		
				(5) clay		
				(6) glass		
				(7) stainless steels		
				(8) plastics		
				(9) cast iron		
				(10) nickel and nickel alloy steels		
				(11) carbon and low carbon steels		
				(12) transite		

CURRICULUM PLANNING GUIDE—
OPERATIONS AND ACTIVITIES—Continued

Block II: Joining Materials—Continued

WHO? A	WHO? J	WHERE? REL	WHERE? OJT	WHAT?	HOW? by Coupling	HOW? Bonding
				b. Join Aluminum & Aluminum Alloys (to):		
				(1) aluminum and aluminum alloys		
				(2) copper and copper alloys		
				(3) brass		
				(4) clay		
				(5) glass		
				(6) stainless steels		
				(7) plastics		
				(8) cast iron		
				(9) nickels and nickel alloy steels		
				(10) carbon and low carbon steels		
				(11) transite		
				c. Join Copper & Copper Alloys (to):		
				(1) copper & copper alloys		
				(2) brass		
				(3) clay		
				(4) glass		
				(5) stainless steels		
				(6) plastics		
				(7) cast iron		
				(8) nickel and nickel alloy steels		
				(9) carbon and low carbon steels		
				(10) transite		
				d. Join Brass (to):		
				(1) brass		
				(2) clay		
				(3) glass		
				(4) stainless steels		
				(5) plastics		
				(6) cast iron		
				(7) nickel and nickel alloy steels		
				(8) carbon and low carbon steels		
				(9) transite		
				e. Join Clay (to):		
				(1) clay		
				(2) glass		
				(3) stainless steels		
				(4) plastics		
				(5) cast iron		
				(6) nickel and nickel alloy steels		
				(7) carbon and low carbon steels		
				(8) transite		

CURRICULUM PLANNING GUIDE—
OPERATIONS AND ACTIVITIES—Continued

Block II: Joining Materials—Continued

WHO? A	WHO? J	WHERE? REL	WHERE? OJT	WHAT?	HOW? by Coupling	HOW? Bonding
				f. Join Glass (to):		
				(1) glass		
				(2) stainless steels		
				(3) plastics		
				(4) cast iron		
				(5) nickel & nickel alloy steels		
				(6) carbon & low carbon steels		
				(7) transite		
				g. Join Stainless Steels (to):		
				(1) stainless steels		
				(2) plastics		
				(3) cast iron		
				(4) nickel & nickel alloy steels		
				(5) carbon & low carbon steels		
				(6) transite		
				h. Join Plastics (to):		
				(1) plastics		
				(2) cast iron		
				(3) nickel & nickel alloy steels		
				(4) carbon & low carbon steels		
				(5) transite		
				i. Join Cast Iron (to):		
				(1) cast iron		
				(2) nickel & nickel alloy steels		
				(3) carbon & low carbon steels		
				(4) transite		
				j. Join nickel & nickel Alloy Steels (to):		
				(1) nickel & nickel alloy steels		
				(2) carbon & low carbon steels		
				(3) transite		
				k. Join Carbon & Low Carbon Steel (to):		
				(1) carbon & low carbon steels		
				(2) transite		
				l. Join Transite (to):		
				(1) transite		

CURRICULUM PLANNING GUIDE—
OPERATIONS AND ACTIVITIES—Continued

TRADE: _____

BLOCK III: Installing Material and Equipment

OPERATIONAL UNITS: A. Locating B. Laying Out C. Rigging D. Assembling

A. Locating (with);
1. transit
2. line level
3. 6' graduated rule
4. 50'-100' measuring tape
5. framing square
6. plumb bob
7. straight edge
8. protractor
9. template
10. wrap around
11. center punch
12. soapstone
13. building level
14. hammer

B. Laying Out (with):
1. 6' graduated rule
2. framing square
3. straight edge
4. protractor
5. template
6. wrap around
7. soapstone

D. Assembling
1. hammer
2. wrench
3. building level
4. framing square
5. straight edge

C. Rigging (with):
1. "come along"
2. block and tackle
3. chain fall
4. "A" frame
5. power hoist
6. winch
7. jacks
8. jack belts and shim stock
9. cribbing
10. rollers

WHO?		WHERE?		WHAT?		HOW?	
A	J	REL	OJT	Install:	by Locating		
				a. soil, waste, and vent pipe			
				b. under ground water main			
				c. underground fire main			
				d. drainfield			
				e. house sewer			
				f. main sewer			
				g. reducers			
				h. branches			
				i. laterals			
				j. down spouts			
				k. stand pipe			
				l. offset			
				m. fitting fabricated from pipe			
				n. septic tank			
				o. grease trap			
				p. bath fixtures			
				q. drinking fountain			
				r. kitchen equipment			
				s. dental equipment			
				t. shower pan			
				u. roof flashing			
				v. water softener			

CURRICULUM PLANNING GUIDE—
OPERATIONS AND ACTIVITIES—Continued

Block III: Installing Material and Equipment—Continued

WHO?		WHERE?		WHAT?	HOW?	
A	J	REL	OJT	Install:	by Locating	Assembling
				w. pumps		
				x. air compressors		
				y. temperature controls		
				z. valves		
				aa. fittings		
				bb. sleeves		
				cc. inserts		
				dd. supports		
				ee. hangers		
				ff. refrigeration compressor		
				gg. coolers		
				hh. chillers		
				ii. condensers		
				jj. humidifiers		
				kk. dehumidifiers		
				ll. instruments		
				mm. industrial controls		
				nn. package boilers		
				oo. unassembled cast iron boiler		
				pp. soot blower		
				qq. fuel burner		
				rr. heater		
				ss. heat exchanger		
				tt. tank		
				uu. fire sensing device		
				vv. flow indicator		
				ww. hydrant		
				xx. post indicator		
				yy.		
				zz.		

CURRICULUM PLANNING GUIDE—
OPERATIONS AND ACTIVITIES—Continued

TRADE: _____

BLOCK IV: Inspecting and Testing

OPERATIONAL UNITS: A. Sensing B. Radiology

A. Sensing (with):
1. compressed air and gage 2. water 3. soap solution 4. water pressure and gage 5. oil pressure and gage 6. gas pressure and gage 7. smoke 8. oil of peppermint 9. gas pressure and halide leak detector 10. percolation 11. ultrasonic wave machine 12. hammer and stethoscope 13. magnetic-particle

B. Radiology (with):
1. x-ray tube and sensitive film 2. gamma-ray and sensitive film

WHO?		WHERE?		WHAT?	HOW?	
A	J	REL.	OJT	Inspect:	by Sensing	Radiology
				a. soil, waste, and vent system		
				b. building sewer		
				c. drainfield area		
				d. interior leader and down spout		
				e. potable water supply		
				f. process water supply		
				g. chemical system		
				h. compressed air system		
				i. oil transfer system		
				j. gas transfer system		
				k. hydraulic oil system		
				l. vacuum system		
				m. steam system		
				n. heating and cooling system		
				o. instruments		
				p. control line		
				q. refrigeration system		
				r. welded system		
				s. fire protection system		
				t.		
				u.		
				v.		

CURRICULUM PLANNING GUIDE—
KNOWLEDGE: CALCULATIONS

WHO? A	WHO? J	WHERE? REL	WHERE? OJT	WHAT? Calculate:	Related Operation and/or Activity
				1. Allowances (for):	
				a. pipe fitting	
				b. pipe bend	
				c. fixture and/or equipment	
				d. rolling offset	
				e. jumper offset	
				f. equal spread offset	
				g. unequal spread offset	
				h. heat loss	
				i. heat gain	
				j. pressure gain	
				k. pressure loss	
				l. expansion	
				m. contraction	
				2. Grade (for):	
				a. drainage	
				b. rise	
				3. Elevation (for):	
				a. location above sea level	
				b. location above bench mark	
				c. location above ground level	
				d. location above floor level	III: A. 1. x 4.
				4. Conversion (for):	
				a. Centigrade scale to Farenheit scale	
				b. Farenheit scale to Centigrade scale	
				c. fraction to decimal equivalent	
				d. English measure to metric measure	
				e. metric measure to English measure	
				f. volume to liquid measure	
				5. Surface area (for):	
				a. triangle	
				b. four-sided figure	
				c. circle	
				d. semicircle	
				e. sector of circle	
				f. segment of circle	
				g. ring	
				h. ellipse	
				i. pyramid	
				j. cylinder	
				k. cone	

CURRICULUM PLANNING GUIDE—
KNOWLEDGE: CALCULATIONS—Continued

WHO? A	WHO? J	WHERE? REL	WHERE? OJT	WHAT? Calculate:	Related Operation and/or Activity
				l. frustrum of cone	
				m. frustrum of pyramid	
				n. sphere	
				o. hemisphere	
				p. composite figure	
				6. Volume and/or capacity (for): a. cylindrical container	
				b. square container	
				c. rectangular container	
				d. spherical container	
				e. segment of a spherical container	
				f. segment of a cylindrical container	
				g. conical container	
				h. composite container	
				7. Rate (for): a. flow	
				b. gain	
				c. loss	
				d. liquid to solid	
				e. solid to liquid	
				f. liquid to gas	
				g. gas to liquid	
				8. Percent (for): a. grade	
				b. increase	
				c. decrease	
				d. comparison	
				e. composition	

*Calculate elevation for location above floor level by relating the calculation to the operation or activity, III. A. 1. x: Install air compressor by locating with transit.

CURRICULUM PLANNING GUIDE—
KNOWLEDGE: VIEWS AND SYMBOLS

WHO? A	WHO? J	WHERE? REL	WHERE? OJT	WHAT? Read and/or interpret:	Related Operation and/or Activity
				a. plan & elevation view	
				b. sectional view	
				c. auxiliary view	
				d. multiplanar view	
				e. isometric projectional view	
				f. dimetric projectional view	
				g. trimetric projectional view	
				h. parallel perspective view	
				i. angular perspective view	
				j. oblique perspective view	
				k. chart	
				l. graph	
				m. diagram	
				n. architectural & structural drawing	
				o. special note & material specification	I:A.4.g. & D.2.g.*
				p. dimension	
				q. fastener symbol	
				r. anchor, clamp, hanger, and support symbol	
				s. bell & spigot fitting symbol	
				t. screw fitting symbol	
				u. flanged fitting symbol	
				v. solder fitting symbol	
				w. braze fitting symbol	
				x. weld fitting symbol	
				y. control symbol	
				z. instrument symbol	
				aa. valve symbol	
				bb. pipe symbol	
				cc. plumbing fixture symbol	
				dd. plumbing equipment symbol	
				ee. heating equipment symbol	
				ff. cooling equipment symbol	
				gg. refrigeration equipment symbol	
				hh. power equipment symbol	
				ii. gas equipment symbol	
				jj. hydraulic equipment symbol	
				kk. fire protection equipment symbol	
				ll. fabrication symbol	
				mm. standard weld symbol	

*Read and interpret special note and material specification by relating the interpretation to the operation or activity, I:A.4.g. & D.2.g.: Prepare stainless steel by cutting with an abrasive wheel and forming with a power bender.

ILLUSTRATIONS OF CURRICULUM PLANNING GUIDE— KNOWLEDGE: TERMS*

WHO? A	WHO? J	WHERE? REL	WHERE? OJT	WHAT?	Related Operation and/or Activity
				Absorber	
				Advance	
				After fill	
				Akron pipe	
				Air chamber	
				Air diffuser	
				Air washer	
				Aligning clamp	
				Alloy	
				Anchors	
				Approach	
				Arc blow	
				Aspiration	
				Backfire	I A 5 k
				Backhand	
				Back pressure	
				Backing ring	
				Backlash	
				Back to back	
				Back water traps	
				Baffle	
				Balancing	
				Balancing cocks	
				Balancing of a system	
				Ball cock	
				Base fitting	
				Bellows	

*The above is a sample page of the "knowledge: terms" portion of a Curriculum Planning Guide. To conserve space and facilitate reading, additional terms are simply listed alphabetically on the following pages.

CURRICULUM PLANNING GUIDE—KNOWLEDGE: TERMS—Continued

Bell trap
Bend
Bending pin
Bibb
Bight
Bleed
Blowhole
Blow-out
Bobbins
Bold end
Bolted bonnet
Bonnet
Booster
Bore
Bossing
Bourdon tube
Bowline
Branch
Brazing
Breathing line
Bulk main
Bull head tees
Bull plug
Butterfly valve
Butt joint
Caliber
Capillary action
Capping
Cascade control
Cascade system
Caulking irons
Center to back
Center to center
Center to throat
Cesspool
Chain fall
Chain tongs
Charge
Chase
Check valve
Chill
Chill bar
Chiller
Choker
Clean-out screw
Clearance
Clevis hanger
Closed loop
Close nipple
Closet bolt
Clove hitch
CO_2 welding
Cold lapping
Combination offset
Come-along
Comfort
Compound offset
Compression bending
Compression bibb
Condenser
Condensate
Constant
Control
Convection
Cool
Cooling tower
Cooling water
Corporation cock
Cowl
Crater
Crease
Cross
Cross main
Cross-over or saddle fitting
Cryogenics
Cup joint
Curb-box
Curb cock
Dead end
Dehydrate
Dew point
Diffusers
Desiccant
Distributor
Diversion fittings
Dope
Downfeed system
Drag
Draw bending
Drier
Drift plug
Drip
Drop
Drop ell
Drop T
Drum trap
Dummy
Dutchman
Dynamic head
Earthquake braces
Economizer
Elbow clamp
Electrolysis
Elevations
End to center

CURRICULUM PLANNING GUIDE—KNOWLEDGE: TERMS—Continued

End to end
Enthalpy
Entropy
Escutcheon
Equalizer
Equal spacing
Eutectic
Evaporation
Exfiltration
Expansion joint
Expansion tanks
Face to face
Feather
Feathered tack
Ferrule
Fill cups
Fillet
Flash chamber
Flash gas
Fin
Fine wire welding
Fire cracking
Fitting angle
Fit-up pin
Flash
Flashback
Flange jack
Flange square
Flat dresser
Floor flange
Flux
Foaming
Follower
Forehand
Foul gas
Frost back
Fuller bibb
Fusible plug
Gate valve
Glass
Globe valve
Gooseneck
Grade
Gunner's piece
Half hitch
Half Y
Hangers
Head
Headers
Head pressure
Heat pump
Hickey
High side
Hot cracks
Hub
Humidistat
Hydrolysis
Hydronics
Hygroscopic
Inner cone
Interface measurement
Jacket water
Jamming
Jam nut
Joint runner
Jumper offset
Kerf
Kickers
Lag
Lantern ring
Lap joint
Latent heat
Lateral
Lazy man
Lead
Lead burning
Lead wool
Link pipecutter
Liquefaction
Load
Load voltage
Lock-bibb
Lock-stop
Log
Loop system
Loops with grade
Mains
Making up
Make-up water
Male and female
Mig welding
Milinch
Muffer
Needle valve
Neutral flame
Nipple chuck
Oakum
Offset
Oil still
Oil trap
Old man
Oxide
Oxidize
Oxidizing flame
Ozone
Package boilers
Padding
Panel coils

CURRICULUM PLANNING GUIDE—
KNOWLEDGE: TERMS—Continued

Panel heating
Phase
Pickling
Piezometer rings
Pig-eared corners
Pipe crusher
Plenum chamber
Plumbers candle
Plumbers soil
Plunger
Polarity
Poor fit-up rod
Pop rivets
Portable power drive
Porta-power
Psychrometer
"P" trap
Puddle
Purger
Purging
Pyrometer
Radiant heating
Radiation
Rain leader
Ram bending
Receptor
Reducing flame
Relief valve
Reverse polarity
Rise
Risers
Road box
Rodding
Roll bending
Rolling offset
Roof pitch
Root opening
Root pass
Roughing-in
Round dresser
Run
Running end
Runout
Rust joint
Saddle
Safe
Safety head
Sand plug
Scissor the pipe
Scratch cloth
Screwed bonnet
Scribbing plates
Sensible heat
Serpentining of evaporators
Set
Set back
Sewer gas
Shave hook
Shell and tube
Short cycling
Shrunk joint
Siamese connection
Silical gel
Single-leg sling
Siphon breakers
Sitz-bath
Sizing a system
Skelp
Sludge
Snake
Snubber
Soil pipe
Solder
Space riser
Spacing
Span
Spanner wrench
Spatter
Spigot
Split-heating
Spray pond
Spread
Spring piece
Spug wrench
Square-end rig jig
Square head cocks
Square knot
Stand pipe
Standing part
Star drill
Static pressure
Steam header
Stick welding
Stock
Stopcocks
Straight polarity
Strap wrench
Street washer
Stretch bending
Stub
Stuffing box
Sublimation

CURRICULUM PLANNING GUIDE—
KNOWLEDGE: TERMS—Continued

Submerged Arc welding
Supply trunk
Sweating
Sweep
Swing joints
Tacking
Tail piece
Tap borer
Tee-wye fitting
Test blanks
Thermocouple
Thread chaser
Thrust block
Tig welding
Timing
Trap
Travel
Tube turn
Tucker fitting
Turn pin
Two hole
Undercut
Union bonnet
Unit
Unloader
Urinette
Valve pin
Vapro lock
Venting
Vital heat
Wash-out bowl
Water closet
Water hammer
Wax
Wedge
Weep holes
Weir
Welded fittings
Weldment
Wetting agents
Whipping or seizing
Whiskey stick
Wiping
Wiping solder
Wrap-around
Wrinkle bending
Wye
Wye fitting
Yarning tool
Y strainer
Yoke
Zoning

CURRICULUM PLANNING GUIDE—COMMENTS

A guide will help a group such as JAC to coordinate its training. This can be done by carefully apportioning required learning tasks:

(1) to the apprenticeship (A) or the journeyman continuation training (J) phase, or both; and

(2) to the on-the-job training (OJT) and/or the related instruction (Rel.) sector of training.

Check marks can be used in columns A, J, Rel., and OJT. However, coded entries or subcolumns, such as 1-2-3-4-5 in column A, could specify the year of indenture in which an apprentice would be expected to learn the corresponding set of operations or tasks. Color coding the numerical entries for defined operations or listing the numerical entries in separate rows for A's and for J's would also help distinguish operations reserved for training on the journeyman level.

Additional attention must be devoted to vital problems and issues that bear upon the planning of training in the trades and the optimal use of a management tool, such as the curriculum planning guide.

On what bases should trade skills and knowledge be apportioned to the A and to the J phases of training?

Considering recent advances in educational technology (closed circuit television, computer aided instruction, simulators, single concept films, portable tape recorders, and others), where is the best place—OJT or Rel.—to learn a given operation, including related knowledge? Any decision on such a matter should relate not only to experimental evidence on the best way to perform the operation but also to the best way to learn it to achieve specified standards of performance.

How long does it take to learn an operation or activity? How does this learning time relate to, or affect, the total time of indenture?

On what bases should operations and activities be ordered, or sequenced, during the term of indenture?

- on the basis of frequency of performance in the trade, that is, teaching first that which is done most often? (Work Diary data suggested that in a given period and locality frequency of performance of operations varied considerably.)
- on a logical order of construction or assembly, such as having joining operations preceded by the learning of operations in the preparation of materials?
- on the basis of the critical nature of operations, that is, giving attention first to operations which, if not performed properly, cause death, injury, excessive damage, loss in time, or other serious adversities?
- on a continum from simple to relatively complex operations?
- or, a combination of these and possibly other factors?

How will new and modified operations and activities be identified and related to the curriculum planning guide? For instance, if initiative and ingenuity are to characterize a good journeyman, what activities will be included in training to develop these traits?

Which operations and activities (and what related information) are common among national, local, and other units in the pipe trades?

If they are approached properly, cooperative intertrade efforts can optimize use of instructional materials, facilities, personnel, and other resources by using the best in each trade and by eliminating unnecessary duplications. Purdue data on analysis in the pipe trades suggested that at least one-third of the operations and activities were quite similar, or common, in the three trades. There was evidence that some local training units, especially those involving combination union locals, recognized, accepted, and took advantage of the commonality of certain intertrade practices.

CURRICULUM PLANNING GUIDE—COMMENTS—Continued

Schedule of Work Processes	First 2 Years Joint Training	Last 3 Years Plumbers	Last 3 Years Pipefitters
1. Roughing in, waste, soil, and vent lines	6 mos.	12 mos.	———
2. Installing water lines	6 mos.	12 mos.	———
3. Leadwork (wiping joints, sheet lead and solder work)	1 mo.	2 mo.	———
4. Installing fixtures and appliances	2 mos.	6 mos.	2 mos.
5. Welding	1 mo.	2 mos.	6 mos.
6. Maintenance and repair of plumbing and heating	1 mo.	2 mos.	2 mos.
7. Installation of piping and equipment for heating systems (including oil burner, stokers, and gas-fired equipment and controls)	5 mos.	———	12 mos.
8. Installation of piping and equipment for refrigeration, air conditioning, and ventilating systems	1 mo.	———	10 mos.
9. Industrial process piping and power piping	1 mo.	———	4 mos.
Total	24 mos.	36 mos.	36 mos.

In a training schedule like this one, exposure to both trades, if accompanied by a provision for delayed assignment to a specific trade, should certainly enhance chances for a successful match of learner and trade.

Curriculum planning guides and similar comprehensive control instruments were not well known and utilized in the trades. Seminars, workshops, and other means of learning will have to be made available to training personnel to encourage development and use of such guides.

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